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Information and communications technologies for inclusive social and economic development

Report of the Secretary-General

Executive summary

This report analyses the role of information and communications technologies (ICTs) in enabling inclusive social and economic development. The opening section summarizes developments in the ICT sector and ICT for development (ICT4D) since the World Summit on the Information Society (WSIS), identifying significant trends, experiences and challenges. The report then considers the implications of five emerging trends in ICTs for development, which are expected to play a major part in ICT4D during the next five years. These are: datafication, big-data analysis, cloud computing, the Internet of things, and smart systems. The report concludes with findings and suggestions in the context of the post-2015 development agenda.

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Introduction

1. The significance of ICTs for social and economic development has been recognized since rapid growth in ICTs and their markets began in the mid-1990s. In 1998, for instance, the Commission on Science and Technology for Development (CSTD) published a report titled *Knowledge Societies: Information Technology for Sustainable Development*, which examined the relationship between ICTs, economic and social development, and the potential for building innovative "knowledge societies". The concept of knowledge societies, which has also been adopted by the United Nations Educational, Scientific and Cultural Organization (UNESCO),[2] spans beyond technology, emphasizing the human development processes that transform information into knowledge and enable Governments, people and organizations to effect lasting change in economy and society.

2. The high point of intergovernmental engagement with ICT4D since 1998 was WSIS, held in 2003 and 2005. In its outcome documents,[3] both summits:

(a) Affirmed the international community's commitment to "a people-centred, inclusive and development-oriented information society";[4]

(b) Endorsed and raised awareness of ICTs' potential to facilitate economic growth and social welfare, especially in developing countries;

(c) Established targets and assessment mechanisms for deployment and exploitation of ICTs until 2015.

3. To contribute to a better understanding of the changing nature of ICT issues for inclusive development, and to assist the Commission in its deliberations at its seventeenth session, the UNCTAD secretariat convened an intersessional panel meeting in Washington, D.C., from 2 to 4 December 2013. The present report, requested by Council decision 2013/229, is based on the findings of the panel, national reports contributed by Commission members and other relevant literature. It contributes to the CSTD's work on one of its priority themes for 2013/2014, to assess the role of ICTs in inclusive social and economic development.

I. Information and communications technologies, information and communications technologies for development, and developments since the World Summit on the Information Society

4. The emergence of interest in ICT4D took place within the context of long-term international concern about the challenges facing developing countries, particularly least

[1] R Mansell and U Wehn, 1998, *Knowledge Societies: Information Technology for Sustainable Development*, (United Nations, Oxford University Press). In its *World Development Report 1998/99*, the World Bank also identified knowledge as the critical driver of economic growth and social welfare for the coming century, available at http://www.mojasdatabank.info/wdr98_overview.pdf.

[2] UNESCO, 2005, *Towards Knowledge Societies: UNESCO World Report* (Paris), available at http://unesdoc.unesco.org/images/0014/001418/141843e.pdf.

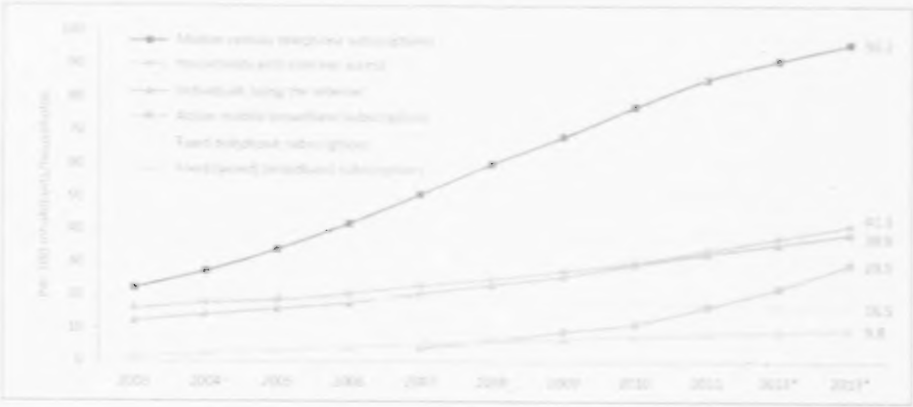
[3] WSIS, United Nations and the International Telecommunication Union, 2005, *WSIS Outcome Documents: Geneva 2003 – Tunis 2005* (International Telecommunication Union, Geneva), available at http://www.itu.int/wsis/outcome/booklet.pdf.

[4] Geneva Declaration of Principles, article 1, in ibid., p.9.

developed countries (LDCs). The United Nations Millennium Declaration of 2000 focused development activity on eight Millennium Development Goals (MDGs), concerned primarily with poverty reduction and basic needs. These have provided the framework for international development policy within which ICT4D has since evolved.

5. The growth of the ICT sector has been highly dynamic. Decades of rapid growth in capabilities of ICT components and networks, illustrated in the figure following, have driven equally rapid innovation in technology and services.

Development in global information and communications technologies access, 2003–2013



Source: International Telecommunication Union (ITU), *Measuring the Information Society, 2013*.[1]
* = estimate.

6. The rate of adoption of ICTs within societies, including developing countries, over the past two decades has exceeded that of any previous technology. The opportunities and challenges presented by ICTs, including the potential of ICT4D, are therefore also subject to rapid change.

A. The impact of information and communications technologies

7. As general-purpose technologies, ICTs value and impact arise primarily from their use in other economic and social sectors. Three ICT capabilities are especially important for economic and social development:

(a) Enabling greater efficiency in economic and social processes;

(b) Enhancing the effectiveness of cooperation between different stakeholders;

(c) Increasing the volume and range of information available to people, businesses and Governments.

8. Realization of these capabilities depends not on technology alone but on the interface between technology and other factors, particularly human capabilities needed to take advantage of them.

[1] ITU, 2013, *Measuring the Information Society 2013* (ITU, Geneva), available at http://www.itu.int/en/ITU-D/Statistics/Documents/publications/mis2013/MIS2013_without_Annex_4.pdf.

9. Achieving an information society is as much about human as technological development. There are two broad, complementary perspectives on ICTs in social and economic development that can be discerned. The first perspective concerns systemic impacts of ICTs, and the second addresses impacts on policymaking.

1. Systemic impacts

10. The systemic impacts which ICTs have had on economies, societies and culture can be grouped under three areas:[6]

(a) Economic impacts, including the globalization of production, changes in international trade and distribution networks, new patterns of consumption of goods and services, the virtualization of some products and behaviours, and the ICT sector's growing importance within global and national economies;

(b) Social impacts, including mass access to greatly increased information resources, enhanced freedom of expression and association, bypassing of national regulation of markets and behaviour, new patterns of work and human settlement, changes in relationships between Governments and citizens, and challenges to traditional ideas of privacy and individuality;

(c) Environmental impacts, including higher levels of waste and carbon generation, and potential mitigation of environmental impacts from other sectors.

11. These impacts have been more profound in developed than developing countries, but are increasingly visible worldwide, posing complex challenges to policymakers. Automation and computerization reduce employment in some sectors, while increasing it in others. The enabling power of ICTs is exploited by criminals as well as legitimate businesses, and raises new challenges of data protection, surveillance and cybersecurity. The ICT sector has become the fastest growing source of physical waste and greenhouse gas emissions.[7]

2. Impacts on policymaking

12. A second set of impacts are related to the potential for Governments and other stakeholders to use ICTs in development strategies, programmes and projects. This emphasizes the active exploitation of technology as a driver to accelerate development through investment in infrastructure, stimulation of demand for ICT devices and applications, and intervention in the form of ICT4D initiatives. It is particularly evident in the work of the World Bank, ITU and the Broadband Commission for Digital Development[8] that national development strategies in countries (such as Rwanda) which

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[6] D Souter and D MacLean, 2012, Changing our understanding of sustainability: The impact of ICTs and the Internet, International Institute for Sustainable Development, available at http://www.iisd.org/pdf/2012/changing_our_understanding_of_sustainability.pdf.

[7] The rate of growth in greenhouse gas emissions from the sector is about 6 per cent per annum; see The Climate Group and Global e-Sustainability Initiative, 2008, SMART 2020: Enabling the low carbon economy in the information age, available at http://www.smart2020.org/_assets/files/02_Smart2020Report.pdf.

[8] T Kelly and CM Rossotto eds, 2012, *Broadband Strategies Handbook*, International Bank for Reconstruction and Development, International Development Association and the World Bank, available at http://broadbandtoolkit.org/Custom/Core/Documents/Broadband%20Strategies%20Handbook.pdf; Broadband Commission for Digital Development, 2011, Broadband: A platform for progress, available at http://www.broadbandcommission.org/Reports/Report_2.pdf.

explicitly focus on knowledge-led development,[9] are at the root of many programme interventions by Governments and international agencies. These range from the promotion of telecentres early in the century to the recent focus on mobile applications for health, education and enterprise development.

13. Framework ICT4D strategies and programmes have increasingly been adopted by developing-country Governments seeking to exploit the potential of ICTs to meet national priorities. Some Governments have emphasized the contribution of communications networks to economic growth by attracting investment and improving efficiency. Others have concentrated on improving administration and service delivery, through e-government and initiatives to enhance health, education and enterprise. Development agencies have emphasized the potential of ICT-enabled impacts on basic needs and MDG priorities. Experience has shown that ICT4D programmes and projects such as these can be quickly overtaken by advances in technology and market reach, and need to be flexible and adaptive to leverage maximum value.

B. The digital divide

14. The nature of the digital divide has been changing over time, both due to rapid change in technology and the highly innovative nature of new ICT applications. What are the most appropriate means of Internet access, how best to promote such access, and for what uses, are becoming key concerns. This rapidly evolving Internet landscape therefore requires a holistic perspective that considers ICTs not only as infrastructure, but as tools for economic development.

15. The changing nature of ICT access and use was recognized through five trends which emerged between 2005 and 2010. They had profound impact on ICT investment, adoption and development potential. These trends were:

(a) Progress towards universal mobile access;

(b) Transition from narrowband to broadband networks;

(c) Cloud computing;

(d) Mobile Internet and mobile applications;

(e) Social networking and user-generated content on the Internet.

16. Mobile telephone subscriptions worldwide have increased since 2005 from 2.2 billion to 6.8 billion, almost one for every person in the world.[10] Rapid growth in mobile networks and devices has also diminished gaps in basic access to the Internet, though concerns remain about affordability.

17. Two fifths of households worldwide already have Internet access. While most households in developed countries now have domestic broadband, this is rare in developing countries where mobile handsets are the most common Internet access platform. The ITU estimates that 77 per cent of individuals in developed countries now use the Internet, but only 31 per cent in developing countries and 16 per cent in sub-Saharan Africa.[11]

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[9] Rwanda's most recent plan is available at http://www.smart2020.org/_assets/files/02_Smart2020Report.pdf.

[10] See http://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2013/ITU_Key_2005-2013_ICT_data.xls.

[11] ITU statistics, available at http://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2013/ITU_Key_2005-2013_ICT_data.xls.

18. High levels of investment are being made in international, national and local broadband networks in most world regions, greatly increasing the capacity of connectivity. High-speed submarine cables are now the principal channels for international connectivity for developing as well as developed countries. Mobile broadband has been the fastest growing market segment, with developing-country subscriptions doubling between 2011 and 2013.[12]

19. These developments contribute to high rates of growth in the volume of data transmitted over networks. Cisco estimates that global Internet Protocol (IP) traffic quadrupled between 2007 and 2012, and will treble again by 2017.[13] Bandwidth usage is reported to be doubling every eighteen months.[14] Other drivers include the migration of data and applications to cloud computing and the emergence of mobile apps which facilitate data access on smartphones. The Internet of things will further drive up data volumes, raising concerns among policymakers about the adequacy of legacy infrastructure and potential spectrum shortages.

20. The growth of online social networks has become a powerful driver of Internet adoption and use in all countries, including developing countries. The most popular network, Facebook, has an estimated 1.25 billion users and is accessed by around 40 per cent of those using the Internet each day.[15] The popularity of social networks and other interactive "web 2.0" services has changed the primary Internet experience for many users from information gathering to interactivity.

21. For the last five years, concern has focused on the growing divide at higher levels of ICTs, particularly broadband, which is now seen as a crucial driver of economic growth. There is particular concern that, while middle income countries are likely to make up this difference in the short to medium term, it will be much more difficult for LDCs to do so. The gap at international level is replicated between more and less developed regions within countries, and between more prosperous and marginalized social groups.

22. The challenge of inclusiveness has been at the heart of ICT4D policymaking. Developed countries have better ICT infrastructure, enjoy more pervasive ICT usage, and gain earlier access to ICT innovations than developing countries. Urban areas and wealthier social groups in developing countries are similarly advantaged over rural areas and poorer communities. ICT access and use are less prevalent in groups that are socially or economically marginalized, such as women, youth, unqualified or subsistence workers, ethnic minorities and those with special needs or disabilities. While the value of ICTs to all is recognized, therefore, its benefits may accrue disproportionately within society.

II. Emerging trends in information and communications technologies, and information and communications technologies for development

23. Further to the five trends that significantly changed the ICT/ICT4D context between 2005 and 2010, some emerging trends that have become prominent since 2010 have the

[12] ITU, 2013, *Measuring the Information Society 2013* (ITU, Geneva), available at http://www.itu.int/en/ITU-D/Statistics/Documents/publications/mis2013/MIS2013_without_Annex_4.pdf, chapter 1.

[13] Cisco, 2013, The zettabyte era – Trends and analysis, available at http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/VNI_Hyperconnectivity_WP.pdf.

[14] See http://spectrum.ieee.org/telecom/wireless/edholms-law-of-bandwidth.

[15] For data on website access and usage, see www.alexa.com.

potential to drive further changes in the relationship between ICTs and development up to and beyond 2015. These are as follows:

(a) Datafication of business and government organization and practice;

(b) The emergence of big data and big-data analysis as new resources for understanding social and economic processes;

(c) Widespread adoption of cloud computing;

(d) The emergence of the Internet of things;

(e) The deployment of smart systems to improve efficiency and productivity throughout economies.

24. None of these trends are entirely new, but all have gained prominence as a result of continued rapid development in ICT technology and markets. For 50 years, the processing speed and capacity of computer processes and components has doubled approximately every two years, a trend known as "Moore's law". This has enabled a 32-fold increase in capabilities since WSIS concluded in 2005, and is ongoing. Its implications can be seen in:

(a) Increased capabilities of computing and ICT equipment, which can manipulate much larger data volumes at much greater speeds year on year;

(b) The much greater volume of data which can be usefully stored and meaningfully analysed;

(c) Increased capabilities of communications networks to transmit data between users and devices irrespective of location.

25. Altogether, these three capability improvements have had particular transformative powers, enabling new types of ICT service, driving innovation in production and consumption of other goods and services, and extending the scope and scale of data analysis and information exchange in ways that impact Governments, businesses and citizens. Those that have access to increased computational and communications capabilities have more opportunities to exploit ICTs for social and economic gain that those that do not. These emerging trends therefore open up new opportunities for social and economic development, but also pose new challenges and risks of development divides.

A. Datafication

26. The term datafication describes the process by which data become the critical resource and determinant of performance in business and government activity, not just within the ICT sector but across entire economies.

27. Most substantial businesses in developed countries, and many in developing countries, now depend on data storage and analysis to maintain performance and gain competitiveness. Datafication is spreading down supply chains, from larger, global corporations to smaller, national and local businesses. Transactional and other relationships between Governments, businesses and citizens are increasingly managed through centralized databases and conducted online. Governments believe that datafication simplifies access, reduces costs, and improves the efficiency of service delivery. E-

government initiatives to promote datafication in developing countries are supported by the World Bank and other agencies.[16]

28. These processes put information and knowledge at the heart of Government and business, and reflect many of the aspirations expressed for information and knowledge societies. Advocates believe that more information and better analysis will lead to more appropriate policymaking, more efficient deployment of resources, increased innovation, new economic and social opportunities, and empowerment of individuals (including the poor) to manage their lives and livelihoods.

29. This provides a platform for improvements in development policy and practice, but unlocking the advantages of datafication depends on more than technology. Economists have long recognized that productivity gains do not automatically arise from ICT investments.[17] Other factors are necessary to secure them, particularly organizational changes that facilitate the efficiency gains that ICT investment renders possible.[18] Those that fail to invest in changes such as management delayering, retraining and the restructuring of supply chains fail to reap the benefits. Expertise and financial resources are also critical in leveraging the potential of datafication.

30. There are other policy challenges. Automating administration leads to job losses and can make interfaces between Government, business and citizens less rather than more transparent. Computerization requires critical business functions to be transferred from human management to algorithms, an outcome many consider risky especially in areas like international finance. The concentration and exploitation of information raises concerns about data protection, privacy and the relationship between individuals, businesses and Government that are politically contentious and administratively challenging. These need to be addressed if the potential of datafication for development is to be fully realized.

B. Big data and big-data analysis

31. The term "big data" describes the accumulation and analysis of greatly increased information resources, beyond the storage and analytical capacity of earlier hardware and software resources. It is made possible by increases in both data storage capacity and the range of available data sources.

32. Big data has great commercial value. Business models of free online services such as Google and Facebook are built around data mining, which represents detailed computational analysis of information supplied by users. Large retail and other businesses likewise acquire, store and mine data on their customers. The information resources and analytical power of big data enable them to market goods and services more effectively than conventional advertizing.

33. Governments also accumulate extensive databases on citizens, businesses and organizations, through established interfaces such as national identity schemes, taxation and education, health and justice systems. These datasets enable Governments to identify priorities and target resources. They become more powerful when conjoined with one another, enabling correlations and associations to be established between different datasets.

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[16] For an example, see http://www.worldbank.org/projects/P081771/e-lanka-development?lang=en&tab=overview.

[17] See E Brynjolfsson, 1993, The productivity paradox of information technology, *Communications of the ACM*, 36(12): 66–77.

[18] Organization for Economic Cooperation and Development (OECD), 2003, *ICT and Economic Growth: Evidence from OECD Countries, Industries and Firms* (OECD publishing, Paris).

Information technology (IT) specialists are also investigating ways of gathering and incorporating tacit (unwritten) knowledge in analysis.

34. Big-data analysis has value at both macro and micro levels. Data and metadata ("data about data") can be both aggregated to discern trends relating to whole populations, or disaggregated to focus on specific geographic, social or economic groups. Data derived from multiple sources can give a more detailed picture of both individual and collective needs and behaviour.

35. However, the value of big data can only be unlocked if data gathered are accurate, reliable and up-to-date, if national statistical offices are capable of high-quality analysis, if decision-makers are prepared to engage with development needs suggested by analysis, and if financial and logistical resources are available to target resources accordingly. These requirements pose challenges to Governments. Large-scale correlations that bring together multiple datasets are complex computational and analytical tasks that require human expertise, sophisticated IT applications and reliable access to high-quality computing and communications. Many developing-country Governments are constrained by lack of analytical capacity as well as limited access to these resources. The direction of causality is often difficult to determine when assessing developmental outcomes.

36. There are also risks in overextending ICT-enabled data gathering. The combination of multiple datasets has great potential for targeting resources, but can be used to discriminate for or against particular communities rather than ensure inclusiveness. Many people are concerned about data privacy and data protection, which require legal regulation. Too much data can overwhelm the capacity of individuals or community organizations to analyse and make effective use of them. It is important for Governments and development partners to identify where big data can add most value to national development and focus resources accordingly.

37. The scale and scope of data analysis are growing rapidly. One recent development, social media analytics, applies big-data approaches to data and metadata posted on online social networks, blogs and microblogs, analysing sentiments as well as the behaviour of user groups. Social media analytics can supplement analysis of conventional data, allowing Governments to learn more about priorities and attitudes towards public services, though it must be remembered that social media users are not demographically representative. Advocates of this approach emphasize its potential for identifying incipient problems – for example, a heightened level of online references to influenza could give early warning of an epidemic. Critics are concerned that repressive Governments could use it to target political dissidents or social minorities.

38. Crowdsourcing, citizen science, and related methodologies exploit telephone and Internet access to extend the range, diversity and scope of data collection by soliciting information from the general population. This allows information to be collected from locations which might not otherwise be reached, complementing sensor and other data sources, though these methodologies face challenges of data quality and manipulation. Successful examples include collection of air, soil and water pollution data, monitoring of election participation, and mapping emergency needs following natural disasters.[19]

39. Data derived from all these sources is becoming more widely disseminated. Open data refers to the publication by Governments of information, including raw data, statistics, analysis and research materials that result from government commissions or public expenditure. The Internet is a highly effective medium for open data publication and for

[19] For examples, see the Ushahidi platforms, available at http://www.ushahidi.com/products.

analytical methodologies such as linked open data, which uses the World Wide Web to bring together data sets that would or could not otherwise be analysed together.[20]

40. Open data policies are associated with freedom of information legislation, enacted in a growing number of countries and consistent with international instruments such as principle 10 of the 1992 Rio Declaration on Environment and Development.[21] They are considered valuable in increasing transparency and accountability, encouraging wider scrutiny of public policy and procurement decisions, enabling greater public participation in policymaking, and diversifying analytical capacity.[22] Publication of data affecting local communities helps them to maximize local opportunities, monitor local officials and protect themselves against threats such as environmental hazards.

41. While legislation has been enacted in many jurisdictions, there have been implementation problems.[23] Significant expenditure is incurred in establishing and maintaining websites and preparing data for publication. Much data has great value to businesses and some question whether Governments should provide this freely, forgoing potential commercial revenue.[24]

42. Datafication and big-data analysis can enable Governments and other development actors to improve understanding and analysis of development challenges, develop better policy responses, stimulate economic activity, and target services and resources where they will have most value. Increased information availability and access can also help citizens and communities reduce vulnerability and identify opportunities to improve quality of life and livelihood. The ability to take advantage of these opportunities depends substantially, however, on the availability of statistical and analytical skills within Government, business and the wider community, and complementary resources, including literacy, educational skills and access to investment funds.

C. Cloud computing

43. Cloud computing provides important resources for datafication and big-data analysis. In this model, not only users' data but also applications are held in data centres managed by IT companies rather than users' own devices, accessed online as and when required. This resembles the client/server computing model that preceded widespread personal computing, but, rather than using in-house servers, takes advantage of the greatly increased computational and communications capacity offered by global IT and telecommunications businesses.[25]

44. Cloud computing has numerous advantages for business and government users. Instead of spending scarce resources on hardware, software and IT management, they can

[20] See, for example, http://linkeddata.org/.

[21] Available at http://www.unep.org/Documents.Multilingual/Default.asp?documentid=78&articleid=1163.

[22] N Rajshree and B Srivastava, 2012, Open government data for tackling corruption – a perspective; paper presented at the Association for the Advancement of Artificial Intelligence workshop on Semantic Cities, Toronto, 23 July.

[23] See https://opendata.co.ke; http://www.nation.co.ke/business/news/Open-data-initiative-has-hit-a-dead-end/-/1006/1617026/-/n18uhrz/-/index.html.

[24] See for example, R Kitchin, 2013, Four critiques of open data initiatives, available at http://www.nuim.ie/progcity/2013/11/four-critiques-of-open-data-initiatives/.

[25] UNCTAD, 2013, *Information Economy Report 2013: The Cloud Economy and Developing Countries* (United Nations publication, Geneva), available at http://unctad.org/en/PublicationsLibrary/ier2013_en.pdf.

procure these more flexibly from cloud providers, varying capacity as needed, using mobile as well as personal computer platforms. Shared access to such large resources enables clients, including Governments, to benefit from substantial economies of scale. Business savings are estimated at up to 40 per cent of IT costs, though these vary between business contexts.[26]

45. One estimate suggests the global cloud market will treble between 2010 and 2015, rising to US$43.3 billion, though estimates vary reflecting uncertainty in predicting ICT trends.[27] Although concentrated in developed countries, cloud services are spreading rapidly in emerging markets and middle-income countries. Individuals everywhere make extensive, unconscious, use of cloud-based services for electronic mail, social networking and entertainment access. Many global and developed-country businesses manage customer relations through cloud services provided by companies such as Salesforce, or use cloud-based tools offered by providers such as Amazon Web Services to manage business processes and offer information services.[28] Some developed-country Governments have now prioritized cloud procurement, to take advantage of perceived efficiency and cost savings.[29]

46. While Governments are keen to benefit from savings derived from cloud procurement, many have concerns about loss of sovereignty over data and applications if these are outsourced to global cloud providers. Large-scale data centres cost as much as US$1 billion to deploy. Economies of scope and scale result in the dominance of global cloud provision by very large IT companies. Many Governments fear they may become locked into contracts which become uncompetitive or are insufficiently interoperable, or are concerned that cloud-based data will be vulnerable to surveillance or hacking by unauthorized third parties, including other Governments. These reservations inhibit cloud adoption. Reliance on cloud-based services also depends on the quality of national communications and power infrastructures, which remain deficient in many developing countries.

47. Governments of developing countries can tap into the potential of the cloud by carefully assessing potential costs and benefits before making procurement commitments, but also by positively addressing infrastructure, legal and other constraints which currently discourage cloud provisioning.[30] Further opportunities abound for developing-country businesses. Some countries may be able to establish national data-centre markets, fulfilling the desire of Governments and businesses to retain data in-country while still accessing services from global cloud providers. The Government of Kenya, for example, has commissioned data centres to provide facilities not just for government departments but also national and regional businesses concerned about data sovereignty. There is also scope for development of cloud aggregation and brokerage services, and of innovative cloud-based applications addressing local information needs.

48. Cloud computing seems poised to spread rapidly through developing economies, with potentially profound impacts on business costs and the ability of firms to innovate. Maximizing its value depends, however, on the availability of reliable, high-quality

[26] Ibid.

[27] Cited in R Berry and M Reisman, 2012, Policy challenges of cross-border cloud computing, *Journal of International Commerce and Economics*, available at http://www.usitc.gov/journals/policy_challenges_of_cross-border_cloud_computing.pdf.

[28] Examples can be found at http://aws.amazon.com/solutions/case-studies/all/.

[29] UNCTAD, 2013, *Information Economy Report 2013: The Cloud Economy and Developing Countries* (United Nations publication, Geneva), available at http://unctad.org/en/PublicationsLibrary/ier2013_en.pdf, pp. 60 and 91.

[30] Ibid.

broadband infrastructure and steps to overcome challenges of data protection and data sovereignty.

D. The Internet of things

49. The Internet of things will extend the reach of connectivity beyond people and organizations to include objects and devices. Businesses and administrative systems already connect and monitor objects and devices through radio-frequency identification tags and global positioning systems. The Internet of things will take this further, enabling anything to which an IP address can be attached – "everything from tyres to toothbrushes"[31] – to be connected, respond to digital instructions, and gather data for analysis.

50. The Internet of things requires an increased availability of IP addresses. The Internet is migrating to a new version of the IP, IPv6, which vastly expands the number of available addresses, eliminating their shortage in IPv4. Transition has been slow, with only 3.75 per cent of websites worldwide using IPv6 in November 2013, but is expected to accelerate.[32]

51. The advocates of the Internet of things envisage it leading to "a plethora of innovative applications and services, which will enhance quality of life and reduce inequalities whilst providing new revenue opportunities for a host of enterprising businesses" including "medical diagnosis and treatment, cleaner water, improved sanitation, energy production, the export of commodities and food security".[33] Few such applications have yet emerged. However, Internet-connected sensors are now widely used to monitor weather patterns, pollution levels and traffic patterns, enhancing government capacity to intervene in short-term crises and to develop better-informed, more effective long-term policies.[34] Sensor-derived data can be published as open data, reinforcing participation in monitoring and helping individuals respond appropriately to changing circumstances.

52. In developing countries, the principal short-term impact of the Internet of things is likely to concern specific applications given overall ICT infrastructure issues. Radio-frequency identification tags and global positioning systems, for example, can facilitate monitoring of trade consignments along supply chains, or help to manage the supply of educational materials and drugs in schools and clinics. Devices attached to vehicles can gather real-time information about traffic flows, enabling better traffic management – a major challenge in large, complex urban environments with poor infrastructure. Remote sensors can play an increasingly important part in monitoring environmental hazards such as climate change, health emergencies, and social unrest, enabling more timely adaptation, not least at local levels.

53. The Internet of things could reshape the relationship between people and devices as well. Alongside these potentially beneficial outcomes, however, the arrival of the Internet of things has intensified concerns over privacy and data protection. The information generated will greatly increase individual data footprints, enabling greater scrutiny of behaviour by Governments and businesses. The balance between information availability

[31] See http://www.itu.int/osg/spu/publications/internetofthings/.

[32] See http://w3techs.com/technologies/details/ce-ipv6/all/all.

[33] ITU, 2005, *The Internet of Things*, ITU, Geneva, available at http://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-IR.IT-2005-SUM-PDF-E.pdf.

[34] The city of Porto in Portugal, for example, has seen a number of pilot studies to exploit the connectedness of vehicles and sensory devices for improving civic management. See presentation by Joao Barros on innovative ICT applications in Porto, Portugal, at the Internet Governance Forum, Bali, 22 October 2013, see http://www.intgovforum.org/.

and confidentiality is likely to be a major factor in public policy debate around the development of the Internet of things.

E. Smart systems

54. Smart systems are ICT-enabled processes that facilitate more efficient production, distribution and consumption of goods and services. Their potential has been explored in a 2008 report of the business-led Global e-Sustainability Initiative,[35] which identified four sectors in which substantial financial and carbon savings could result from ICT deployment, namely:

(a) Smart motors (automation and monitoring in manufacturing);

(b) Smart logistics (transport and storage management);

(c) Smart buildings (building design, management and automation);

(d) Smart grids (management of electricity generation and distribution).

55. Smart systems can have substantial impacts on financial and environmental costs of non-ICT infrastructure, reducing waste, stimulating development and affecting global policies on sustainability and climate change. They have particular potential in power and transport infrastructures. Improved efficiency in these sectors should lower costs, increase availability and affordability of goods and services, and reduce the environmental footprint of industrial and utility processes. Smart grids illustrate the potential.

56. The use of ICT tools in power generation and distribution can avoid excess production and reduce waste in energy supply, while improved real-time communications with end-users should improve efficiency in energy consumption. The scope for savings is greatest in developed countries, which have high levels of power usage, but smart grids are also relevant for developing countries where energy production and consumption are expected to increase substantially. The Global e-Sustainability Initiative claims that smart grids could reduce losses in power transport and distribution in India by 30 per cent, achieving substantial financial and carbon savings.[36]

57. Smart systems share some characteristics with the Internet of things. Though operating at a larger scale, and incorporating a wider range of ICT technologies and applications, they rely significantly on monitoring distributed devices such as electricity meters to gather data and maximize efficiency. However, smart systems require considerable capital investment in relevant sectors, as well as in high quality, reliable communications. As with the emerging trends discussed above, fulfilment of their potential depends on human and financial as well as technological resources.

[35] The Climate Group and Global e-Sustainability Initiative, 2008, SMART 2020: Enabling the low carbon economy in the information age, available at http://www.smart2020.org/_assets/files/02_Smart2020Report.pdf.

[36] Ibid., pp. 9 and 45–46.

III. The development potential of emerging trends

A. Emerging information and communications technology trends and the digital divide

58. The five emerging trends described in this paper illustrate the opportunities arising from ongoing advances in ICTs, and also the challenges that developing countries will experience in realizing these opportunities. These five inter-related trends can, therefore, substantially enhance the impact of ICTs on social and economic development, bringing developing countries closer to the information and knowledge societies envisaged in the 1990s and at WSIS. All five are enabled by extraordinary growth in the capabilities of computing and communications technologies which has occurred over the past decade and is ongoing. As a result, they can both improve the efficiency, coordination and cost-effectiveness of existing business and government practice, and enable business and government activities which were previously unfeasible.

59. The crucial operative word, however, is "can". Experience with ICT4D over the past decade has demonstrated the risk of focusing on the potential of ICTs in ideal circumstances without considering the contextual constraints surrounding their deployment. These include the availability, affordability and reliability of infrastructure; the quality of the legal and regulatory framework for innovation; human and institutional capabilities needed to leverage developmental value from programmes and projects; and financial resources for investment in infrastructure, human capacity and operational costs.

60. The emergence and growing importance of these five trends illustrates the pace of change in ICTs and ICT4D. They represent a stage in the ongoing development of technology and markets. Further waves of innovation, including new interfaces between people and devices, such as Google Glass, speech-based computing and automated translation suggest directions in which consumer technology and applications may evolve in the near future. The World Wide Web Consortium advocates development of the "semantic web", which would enable automated agents to perform online tasks without users' direct intervention. Research into self-regulating algorithms, artificial intelligence and organic computing also suggests trajectories for the next generation of innovation.

61. The adoption and use of ICTs have already had systemic impacts in many areas of human activity: in patterns of economic production, distribution and consumption; access to information and knowledge; the dynamics of relationships between Governments, businesses and citizens; and patterns of work, leisure and human settlement. Alongside these systemic impacts, Government and donors have sought to leverage positive outcomes from ICTs in critical areas of social and economic development, particularly health, education and enterprise development. National ICT4D strategies and programmes have contributed substantially to economic and social development since WSIS, facilitating economic growth and supporting the achievement of basic needs identified in MDGs.

62. While ICTs' impact has been greatest in developed countries, it has been substantial also in developing countries, including LDCs. Trends towards mobility, broadband and web 2.0 have contributed greatly to this outcome. The rapid spread of mobile phones, in particular, has brought information and communications opportunities that were previously confined to high-income groups and urban areas to low-income communities and rural districts. Governments have sought to accelerate their impact by stimulating infrastructure deployment through universal access programmes and, in some cases, direct investment. However, while this has enhanced inclusiveness in access and opportunity, significant digital divides remain between and within countries, particularly where broadband is concerned.

63. Although most developing regions are seeing significant investment, broadband access remains limited in many developing countries. This causes particular concern as broadband networks are essential for developing countries to make full use of more sophisticated ICT services and applications, including those discussed in this paper. These require reliable, high-quality broadband networks capable of consistently transmitting large data volumes at low prices, nationally and internationally. Reliability in this context includes redundancy (alternate routings in the event of network failure) and adequate power supplies to maintain operating levels.

64. Given that ICTs impact on all development sectors, digital divides are liable to exacerbate gaps in development outcomes between more and less well-provisioned countries, between regions within countries, and between different social groups. The high dependency of cloud computing and smart systems on broadband infrastructure means their positive impacts are likely to be felt more intensively in developed than developing countries, in middle-income countries than in LDCs, and in urban than in rural areas. A growing broadband digital divide could therefore exacerbate other development divides.

65. Not all economic sectors are equally affected by ICTs. Many LDCs are generally more dependent on raw material extraction and agriculture, and less on manufacturing and services. These sectors are less susceptible to ICTs. Substantial gains can also still arise in LDCs from wider deployment and application of basic ICTs. While these factors may mitigate the impact of later broadband deployment in lower-income countries, they do not obviate the importance of broadband investment for unlocking benefits from the emerging trends discussed above, not least for economic diversification and social welfare.

66. It should be noted, too, that digital divides are sustained by the rapid pace of innovation in ICT technology and markets. New infrastructure will always be deployed first where it is most likely to secure rapid return on investment. New services will always be bought first by those that can most readily afford them. It is important for policymakers to focus not only on absolute levels of access to ICT resources, but also on access trends. Developing countries which exhibit strong positive growth in ICT capabilities are better placed to take advantage of ICTs, including emerging trends, than those lacking a positive growth trajectory.

B. Public policy requirements for maximizing the value of emerging trends

67. Two conclusions concerning government policy can be drawn from this discussion of emerging trends.

68. Firstly, Governments should take a holistic approach to the relationship between ICTs and development. ICT impacts do not occur in isolation, but in a context of wider change, including shifts in economic power between and within countries, advances in other areas of science and technology such as agricultural production, continued population growth, and threats posed by climate change, pollution and depleted natural resources. Geographic and demographic inequalities, gender inclusiveness and political stability/instability also play important parts in determining the likely impact of ICTs and scope for policy intervention. Governments should acknowledge the increased and increasing importance of ICTs and recognize that their impact is integral to the complex dynamics of political, economic, social and environmental changes that are occurring in national economies and societies. Inclusive policies for ICT4D need to address issues of affordability, accessibility, appropriate content, and education if they are to ensure that ICTs help to reduce inequalities and enhance social and economic inclusiveness.

69. Secondly, Governments should pay attention to the enabling economic and infrastructural environment for ICTs and ICT4D. Infrastructural investment is crucial to

developing countries' capacity to engage successfully with these emerging trends. Most investment will come from the private sector. However, the scale of investment needed in broadband upgrading is very substantial. Private businesses focus on countries and districts from which high short-term returns can be expected. There is a renewed trend towards infrastructure investment by developing-country Governments, backed by international financial institutions and or equipment/network vendors. The World Bank, for example, has supported the development of a regional backbone network for the under-resourced and under-connected Central African region.[37] Such investment should continue where needed to stimulate inclusive social and economic outcomes.

70. Network access also needs to be affordable. Networks and services in developing countries typically cost more than those in developed countries, inhibiting adoption of bandwidth-dependent innovations such as cloud computing. Developing countries also typically experience less competition in broadband provision. In this context, establishing regulatory institutions that guarantee economic competition and encourage universal coverage, convergence, quality and access, is vital. Regulatory mechanisms such as open access to backbone infrastructure, infrastructure-sharing and cost-based interconnection can also play important parts in enhancing competition and reducing prices.

71. Reliability is also crucial. Sufficient redundancy needs to be built into networks to maintain connectivity when infrastructure fails. Low latency – the time delay between parties to a connection – is important in maximizing the cost-effectiveness of connectivity for cloud computing and can be improved by the deployment of country-level Internet exchange points.

72. Experience in developed and developing countries shows that appropriate legal and regulatory environments are needed for Governments and businesses to take advantage of emerging trends.

73. Legislation and regulation are needed to enable digital transactions and exchanges. Although international models are available,[38] these are still not enacted in many developing countries, inhibiting the spread of electronic commerce. Banking and business cultures must also adapt to take advantage of digital transactions and services.

74. A positive enabling environment is needed for business development and innovation. Many developing countries rank poorly in the World Bank Doing Business index which measures business regulation.[39] Governments should reduce constraints on business innovation where this will encourage adoption of ICT-enabled opportunities.

75. Legislation concerning data protection, data sovereignty and cybersecurity is also crucial. Data subjects need confidence that data will be used for their benefit, and are not susceptible to hacking and criminal activity. Governments have important concerns about data sovereignty, international surveillance, and the risk of cyberattacks.

76. Open standards play an important part in encouraging innovation, and facilitating interoperability between hardware, software and business systems. Effective data

[37] See the Central African Backbone Program Project, available at http://www.worldbank.org/projects/P108308/central-african-backbone-apl1a?lang=en&tab=overview.

[38] For example, the United Nations Commission on International Trade Law, 1996, Model Law on Electronic Commerce, available at http://www.uncitral.org/uncitral/en/uncitral_texts/electronic_commerce/1996Model.html; and UNCTAD, 2013, *Review of E-commerce Legislation Harmonization in the Association of Southeast Asian Nations* (United Nations publication, Geneva), available at http://unctad.org/en/PublicationsLibrary/dtlstict2013d1_en.pdf.

[39] See http://www.doingbusiness.org/rankings.

communications rely on interoperability between systems used by different Governments and businesses, both nationally and internationally.

77. Above all, experience suggests that Governments need a thorough understanding of their national communications and development environments when designing policies and programmes for ICT4D. International experience can be valuable, but must be treated cautiously. Later adopters of new technology can learn from the experience of early adopters, both positive and negative, but policies and programmes need to be tailored to national circumstances and needs, which may differ considerably from those of other countries. Particular attention should be paid to constraints affecting the deployment of ICTs, including limited infrastructure, power, and financial and human resources. Just as important is the pace of change in ICT technology and services.

IV. Information and communications technologies and the post-2015 development agenda

78. The next two years will be a crucial period for international cooperation on social and economic development and ICT4D. In 2015, the United Nations General Assembly will review development performance against the MDGs which, since 2000, have focused global policy on poverty reduction and social welfare.[40] The Assembly will adopt a new post-2015 development agenda, drawing on this review, evidence from sources including the Secretary-General's High-level Panel of Eminent Persons on the Post-2015 Development Agenda,[41] and input from other United Nations processes, particularly the Rio+20 Earth Summit. Work is already underway to design the Sustainable Development Goals, which will form a central part of this agenda.[42] The General Assembly will also review implementation of WSIS outcomes and the relationship between ICTs and other development sectors.

79. A ten-year review of WSIS outcomes will take place within this context. The first WSIS+10 event was organized by UNESCO in February 2013.[43] A high-level event organized by ITU is scheduled for 2014,[44] while a statistical assessment of WSIS outcomes will be published by the Partnership on Measuring ICT for Development. Further review arrangements will be made by the General Assembly.

80. The confluence of these reviews provides an opportunity for the role and significance of ICTs in social and economic development, including the contribution of emerging trends discussed in this paper, to be incorporated more systematically within the global development agenda.

81. International agencies concerned with technology and development have placed considerable emphasis since WSIS on the growing significance of ICTs and their potential to enhance development, including the MDGs.

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[40] See http://www.un.org/millenniumgoals/.

[41] *A New Global Partnership: Eradicate Poverty and Transform Economies through Sustainable Development*, report of the High-level Panel of Eminent Persons on the Post-2015 Development Agenda (United Nations publication, New York), available at http://www.un.org/sg/management/pdf/HLP_P2015_Report.pdf.

[42] See http://sustainabledevelopment.un.org/index.php?menu=1300; and see work of the United Nations Sustainable Development Solutions Network at http://unsdsn.org/.

[43] Towards Knowledge Societies for Peace and Sustainable Development – First WSIS+10 Review Meeting; documentation available at http://www.unesco.org/new/en/communication-and-information/flagship-project-activities/unesco-and-wsis/wsis-10-review-meeting/.

[44] See http://www.itu.int/wsis/implementation/2014/forum/.

82. Many Governments and international agencies have gained significant experience in designing and implementing strategies, programmes and projects that exploit the potential of ICTs for inclusive social and economic development. Their experience, positive and negative, will form a crucial part of the WSIS+10 review. It provides a sound basis for the realistic and systematic integration of ICTs within the post-2015 development agenda, recognizing both opportunities and challenges associated with ICTs and their growing impact on economy, society and culture.

83. However, the understanding of this potential, and of the underlying systemic changes in economy and society resulting from an emerging information society, is not yet pervasive in development discourse. While recognizing that these are at an early stage, they have not featured prominently in discussions towards the post-2015 development agenda. More dialogue is needed between ICT/ICT4D and other development domains to deepen and strengthen understanding of the contribution that ICTs can make to sustainable development and the potentialities for inclusive social and economic development of emerging knowledge societies.

V. Findings and suggestions

A. Findings

84. The findings of this Report are summarized as follows:

(a) The digital divide is changing its nature, from ICT access to how ICTs can be used to promote development outcomes. The constant emergence of new applications are creating a rift between those who have the ability to benefit from them, and those who are excluded. Many developing countries, especially LDCs, risk being further impacted by the digital divide.

(b) The success of deploying ICTs in countries depends on following an ecosystem approach that engages all stakeholders and ensures comprehensive and coordinated incorporation of all inter-related elements: supply and demand, infrastructure, access, services, policy and regulation, applications, content, capacity-building, digital literacy, funding sources and mechanisms.

(c) Although ICTs provide huge benefits to human welfare, only part of their potential has been realized, and spaces of exclusion remain.

(d) ICTs need to be considered innovatively in terms of technology, business and regulation. A mindset of abundance, and not of scarcity, should be adopted, with the intention of creating more than what is currently available.

(e) There is unevenness in the production and dissemination of information on the Internet, which is not necessarily linked to lack of Internet penetration. Existing zones of exclusion in the world, for example in education, as well as existing stereotypes, are being amplified on the Internet.

(f) Affordability and the sustainability of financing for ICT projects persist as key issues.

(g) ICTs provide new solutions and opportunities for inclusion of segments of society such as people with special needs and the elderly.

(h) ICTs play an important role in enhancing the transparency and accountability of Governments and businesses.

(i) ICTs such as social media and crowdsourcing provide new possibilities for location-enabled services to citizens, especially in the context of natural disasters, as well as conflict management.

B. Suggestions

85. The CSTD is encouraged to take the following steps:

(a) The Commission should play an active role in creating awareness on the potential contribution of ICTs to the post-2015 development agenda through substantive inputs to relevant processes and bodies of the United Nations.

(b) The Commission should continue to share findings and best practices on ICTs among member States and beyond.

86. Member States, especially developing countries, are encouraged to consider the following suggestions:

(a) Systematic research on new ICT trends and their impact on development can facilitate a more nuanced understanding of the opportunities and risks they pose, particularly in the post-2015 development agenda.

(b) ICTs should be promoted through a capability-based approach rather than a needs-based approach that rests on the foundations of learning, innovation and competence-building systems.

(c) Member States should seek international cooperation opportunities in ICTs, particularly in terms of identifying best practices on e-education, e-government, e-health and disaster resilience through existing and new cooperation platforms.

(d) Member States should seek to create autonomous ICT institutions, based on sound institutional frameworks that guarantee economic competition and content plurality, and encourage universal coverage, convergence, quality and access.

(e) The gender gap in ICTs, which is particularly prevalent in Africa and South Asia,[45] should be addressed by creative, demand-stimulating regulation that popularizes ICTs and encourages the participation of women.

87. The international community should consider the following:

(a) The importance of ICTs and their impact on social and economic change will continue to grow. Therefore, the potential of ICTs for enabling sustainable development, addressing the needs of development goals, and building knowledge societies should be articulated and included in the post-2015 development agenda.

(b) There is a need to continuously measure global progress in terms of ICT adoption through data collection and the development of indexes that measure a broad array of data points. The ability to develop the right policy responses largely depends on identifying gaps and establishing targets based on such data.

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[45] See http://www.intel.com/content/dam/www/public/us/en/documents/pdf/women-and-the-web.pdf.